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**The Effects of a McKenzie-Based Approach Combined with Functional
Training for a Patient with Low Back Pain and Multiple Sclerosis: A
Case Report**

By

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B.S., Eastern Illinois University, 2012

CAPSTONE PROJECT

Submitted in partial fulfillment of the requirements

For the Degree of Doctorate of Physical Therapy

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ABSTRACT

Background and Purpose: The purpose of this case report is to describe the outcome of a McKenzie-based intervention plan combined with functional training for a patient with low back pain and multiple sclerosis.

Case Description: CS was a 58-year-old female who presented to therapy with primary complaints of low back and calf pain. Also, the patient was diagnosed with relapsing-remitting multiple sclerosis in 2009. The patient ambulates with a significantly increased base of support. A CT-scan in 2012 revealed a bulging disc at the L5-S1 vertebral junction. The patient swims 3x a week for 30 minutes.

Outcomes: All of the patient's impairments improved except for the pain in her calves. According to the Revised Oswestry Index, CS was classified as mildly disabled by the end of treatment, but was initially found to be severely disabled.

Discussion: Pain and functional improvement can be made regardless of being hindered by MS, an incurable disease. MDT is an effective method treating back related impairments. However, it appears to have no effect regarding pains caused by MS.

BACKGROUND AND PURPOSE

A study was conducted in 2010 to estimate the global burden of low back pain. Out of 291 conditions, low back pain was found to be the most prevalent cause of global disability than any other condition.¹ There has been a variety of research supporting different interventions for low back pain. One form of treatment has been strongly supported by research over the past 33 years, mechanical diagnosis and therapy (MDT) also known as the McKenzie method. An MDT-based protocol design is based on a patient's response to specific positions and movements. MDT requires finding a directional preference (DP) and implementing it in the patient's prescribed exercises. Donelson et al. conducted a study that randomly assigned subjects with low back pain to one of three groups, matched DP, opposite of DP, or evidence-based research. Subjects from the matched DP group yielded greater improvement in all six forms of outcome measures testing the following: back pain intensity, leg pain intensity, Roland-Morris DQ, pills per day for low back pain, Beck Depression Inventory, and interference with activity.² Chronic back pain has been shown to make significant improvements in a short amount of time with MDT. Al-obaidi et al. found significant improvements in individuals with chronic back pain after 5 weeks of a McKenzie-based plan of care.³

Multiple sclerosis (MS) is a neurological disease causing numbness, weakness, visual impairments, tingling, fatigue, and dizziness. Relapsing-remitting multiple sclerosis (RRMS) is the most common consisting of 60 to 70% of all cases. Signs and symptoms typically cause functional impairments with gait and balance. Gunn et al. completed a meta-analysis of 8 articles (N=1,929) classifying 53.75% as fallers.⁴ Hadjimichael et al. conducted a study to examine the prevalence of persistent pain and uncomfortable sensations for individuals diagnosed with MS. Over 10,000 subjects responded to a questionnaire assessing pain. The study found 49% of respondents reported of being hindered by some form of mild to severe pain.⁵ Signs and symptoms may differ depending on what neurological fibers are effected. This perceived interference with quality of life necessitates greater attention by healthcare providers to the management and uncomfortable sensations in the MS population.⁵ Researchers have found physical activity as an excellent beneficiary for maintenance of the condition.⁶ Physical therapy treatments focusing on postural control, normalization of gait patterns, increasing range of motion, and strengthening musculature have all proven to be effective for improving disability.⁷

There is currently no research investigating the use of an MTD approach to rehab individuals with MS. Previous studies have shown improvements can be accomplished with this unchanging impairment.^{6,7}

However, the effects of researched supported interventions paired with the optimal effects of a McKenzie-based plan could yield even higher positive rehab outcomes. The purpose of this study was to research the effects of a McKenzie-based approach combined with MS research supported methods for a patient with low back pain and multiple sclerosis.

CASE DESCRIPTION

Subject

CS was a 58-year-old female who presented to therapy with a chief complaint of low back pain (LBP) occurring over the past 2 years. She also reported bilateral calf pain. The subject's medical history included a diagnosis of relapsing-remitting multiple sclerosis (RRMS) in 2009. She stated, "Some days the MS does not bother me, while others it feels like my entire body hurts." CS ambulates with a widened base of support due to her decreased balance and lower leg pain. Resulting in decreased stride length and gait speed. Her impaired balance and pain had a negative impact on her endurance as well. She was only able to ambulate 5 minutes before lower back and leg pain was intolerable. This forced her to take a sitting break which caused limitations in performance of IADLs. CS also reported difficulty ambulating her 10 stairs at home.

The subject was hospitalized 2 years ago due to severe pain in the lumbo-sacral region of the spine. A CT scan of the L5-S1 vertebral junction revealed a posterior bulging disc. The subject reported she was unable to consistently have full nights of rest due to increased pain of her lower back and calves. She also reported increased back pain when sitting on the couch for 15 minutes or more.

Her current medications stabilized blood pressure, decrease the amount of MS relapses, and decrease overall pain. The patient most likely would have decreased performance in therapy without these medications (Table 1.). CS was retired and currently living with her husband and 15 year-old-son. She swims at her local health club 3 times a week for 30 minutes and reports of having decreased symptoms while in the pool. Informed consent was obtained prior to all data being collected, and HIPAA requirements were met. The subject's goal upon completion of therapy was to walk for longer periods of time and have abolished low back pain.

CS was treated for a mechanical derangement of the lumbar spine. The patient was seen in an outpatient physical therapy clinic 3x a week for 8 weeks for progression of a McKenzie-based lumbar exercise program, with strengthening and manual therapy techniques as needed. Balance training was incorporated in the 5th thru 7th week of therapy per patient request. There was an emphasis on postural strategies and home exercise programs.

The patient was seen for a total of 7 weeks 3 times a week for an hour per session (21 total treatment sessions).

Table 1.

Current medications taken during extent of treatment period (7 weeks)

<i>Name</i>	<i>Dosage</i>	<i>Frequency</i>	<i>Purpose</i>
<i>Betaseron</i>	500 mg	Every other day	Decrease frequency of relapse episodes caused by MS
<i>Celebrex</i>	200 mg	Once a day	Treatment for symptoms of MS
<i>Gabapentin</i>	800 mg	3x a day	Treatment for leg symptoms
<i>Hydrochlorothiazide</i>	20 mg	Once a day	Decrease blood pressure
<i>Ibuprofen</i>	500 mg	As needed	Decrease pain

SYSTEMS REVIEW

Musculoskeletal

CS presented with limitations in AROM with lumbar extension and flexion. The patient reported an increased “stabbing” sensation in her lower back throughout the entire range for both motions. All other ranges were found to be within normal limits (WNL). There was decreased strength about the hip girdle, quads, hamstrings, and gastrocnemius muscles.

Neuromuscular

Based upon clinical observation, it was noted that the patient ambulated with a widened base of support, decreased stride length and gait

speed, lateral leaning over each leg during stance phase, and demonstrated nonverbal indicators of pain by grimacing and leaning onto objects throughout the gym as a coping strategy. This led to decreased functional ability with squatting to pick objects up from the ground and standing up from the ground as well. The patient did not present any balance deficits when she stood and ambulated with her typical widened base. However, the patient was unable to safely perform these tasks with a narrowed base of support. The subject was only capable of walking in the physical therapy gym for 5 minutes before taking a sitting break due to increased pain. CS's lack of endurance limits her ability to ambulate long enough for completion of tasks. All myotomes, dermatomes, and reflexes were unimpaired regardless of having MS.

INITIAL CLINICAL IMPRESSION

Based on the patient's past history and deficits, it was hypothesized her current signs and symptoms were attributed to a lumbar spine impairment. Leg pain is known to be related to back problems, but also could be a result of MS.^{5,8} The patient would be an excellent candidate for a McKenzie-based program if reported lumbar pain can be altered with positional or mechanical testing. Further analysis regarding the nature of the condition was executed to formulate a proper diagnosis. Symptoms of the legs should be closely

monitored along with the back to determine if they are related. Balance was not addressed initially in the plan of care due to her ability to stand and ambulate safely with a widened base of support.

TEST AND MEASURES

Active Range of Motion (AROM)

During the initial examination, CS's range for lumbar spine extension was measured with a universal goniometer and flexion was measured with a flexible tape measure. Lumbar measurements were taken in standing. While measuring lumbar extension, CS was instructed to keep their hands down by their sides and "bend" back as far as possible without falling backwards. The fulcrum was placed in the middle third of the iliac crest while distal and proximal arms were aligned with the midline of the trunk.⁹ While measuring lumbar flexion, CS was instructed to keep their knees straight and try to touch the ground with the tips of their fingers. The tape measure was used to measure distance (cm) from the tip of the 3rd digit to the ground. Each measurement was repeated at the end of week 4 and week 7 of the treatment period. CS was found to have limitations with lumbar extension 10° (normative value: 0°-25°)¹⁰ and lumbar flexion (35 cm). Extension and

flexion were both limited due to increased pain with movement. A summary for AROM results can be found in Table 2. There is little evidence that supports the validity and reliability of measuring ROM for the lumbar spine.¹¹

Manual Muscle Test (MMT)

MMT was used to assess lower-extremity strength at the initial examination, week 4, and week 7 of the treatment period. All strength testing was administered as shown in "Muscle Testing: Techniques of Manual Examination."¹² CS was instructed to keep their hands off of the table to prevent increased leverage of the legs while strength testing when sitting. Repeated single-limb heel raises were used to test each gastrocnemius muscle. During the initial examination, strength deficits were found with bilateral hip flexors (3+/5), hamstrings (4/5), quadriceps (4/5), and gastrocnemius (3-/5). The patient reported increased calf pain when testing both gastrocnemius muscles. A summary for MMT results is shown in Table 2. A literature review of 100 studies has found MMT to be a useful diagnostic tool, but only has fair reliability and validity.¹³

Numeric Pain Rating Scale (NPRS)

The NPRS was used to assess CS's lower back and calf pain, each individually, over the length of treatment. Each session the patient was asked to give a number rating their back and calf pain on the 0-10 scale. A

10 would be indicating severe pain that would require hospitalization and 0 would be no pain at all. The patient's pain rating was reassessed at the end of week 4 and week 7. CS was asked to report her average pain rating over the past 3 days combined to prevent any misconceptions she improved or worsened based off of their symptoms for that day. The patient's baseline scores for a typical day with their LBP was 7/10 and bilateral calf pain 6/10. Both pains were described as "sharp" and "stabbing." Table 2. demonstrates the progression of pain during the treatment period. Childs data collection demonstrated a 2-point change in individuals with LBP is a clinically significant change that therapists can be confident with.¹⁴ The NPRS is shown to be reliable and valid for the assessment of pain for individuals with MS.¹⁵

Revised Oswestry Disability Index (ODI)

The Revised Oswestry Disability Index was completed by the patient at initial examination, week 4, and week 7 of the treatment period. The ODI is a questionnaire consisting of 10 items assessing the degree of disability, quality of life, and limitations of functional activities caused by low back pain. The outcome measure consists of 10 items: pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, traveling, and changing degree of pain. Each item is graded on a scale 0-5 based on the patient's response to each category. A score of 0 correlates to no present disability and 5 is maximum disability. Scores are calculated with the

following formula: $\text{total points}/50 \times 100 = \% \text{ disability}$. The subject is then classified as minimal, moderate, or maximum disability based on their score. The ODI can be argued as the “gold standard” for low back outcome measures.¹⁶

Standard error of measurement was reported as 3.54 (2.62-4.79) for the ODI.¹⁶ The test-retest ability for total ODI score was found to be excellent with an ICC of 0.88 (CI = 95%).¹⁶ MCID was found to be a change in score of 10 or greater.¹⁶ The criterion validity of the ODI has shown to have an adequate correlation with Euroqol (EQ5D) and SF-6D, $r=0.58$ and $r=0.38$ respectively.¹⁶ Construct validity shows adequate correlation between ODI and VAS score for leg pain ($r=0.56$, $p<0.001$).¹⁶ No floor or ceiling effects have been reported.

CS was instructed to answer each question to the best of their ability and should only select one answer per item. When CS was indecisive between two choices, she was informed to go with the statement of higher value. The subject recorded a score of 48% (Table 2.) at initial examination, placing her in the severe disability category of the ODI. She reported difficulties in all categories, but pain intensity, walking, and social life were scored the worst.

Berg Balance Scale (BBS)

The Berg Balance Scale was a tool designed to measure the static balance for adult populations. The objective measurement provides information entailing an individual's fall risk. The test is made up of 14 items, each scored on a scale 0-4. The maximum score is a 56. Individuals that score less than a 45 are considered an increased fall risk. Anyone score in the range 41-56 are considered low fall risk, 21-40 medium fall risk, and 0-20 high fall risk. The BBS has been shown to be a concurrently valid tool when testing static balances for individuals with MS.¹⁷

The BBS was not administered to the patient at their initial examination. The outcome measure was first used at the 4th week reevaluation. The plan of care was initially designed to focus on pain reduction and lower extremity strengthening to improve functional activity performance. CS did not present any significant deficits with static balance disregarding her widened base of support and history of MS. During the 4th week of treatment, the patient voiced her concern being "uncomfortable" on uneven surfaces. Balance training began in the 5th week of treatment (Table 2.) as her primary concerns began to be met.

Directional Preference (DP)

An individual's DP can be identified with a particular position or repeated end-range movements in a single direction (extension, flexion, rotation, or lateral). Identification is confirmed with decreased or abolished

lumbar pain. Also, referred pain originating from the spine that appears to progressively attenuate proximally towards the lumbar midline (known as centralization) supports confirmation. After mechanical assessment, the patient's directional preference (DP) was identified as extension-biased for the lumbar spine at initial examination. The examination was completed by a McKenzie certified therapist who has been practicing for 20 years. Kilpikoski et al. collected data showing interexaminer reliability of a McKenzie lumbar spine assessment when performing tests and identifying LBP symptoms were statistically significant when a McKenzie certified examiner performed the examination.¹⁸

INSERT TABLE 2 HERE

CLINICAL IMPRESSION #2

Multiple impairments were identified upon completion of the initial examination. CS presented AROM deficits with lumbar extension and flexion. Deficits were also found regarding muscle strength of the hip flexors, quadriceps, hamstrings, and both gastrocnemius muscles. She presented to therapy with continuous low back and lower leg pain, 8/10 and 6/10 respectively. The ODI revealed the patient was severely impaired from her current condition which has caused limitations performing ADLs and IADLs. The BBS was not administered at initial examination because she did not

present any deficits in balance, regardless of her widened base of support. The test was administered at a later date to evaluate the patient's current balance at that time. She reported feeling unstable while walking in the grass and other uneven surfaces at the end of the 4th week of treatment. CS scored over a 45 for the BBS which indicated she was not at an increased fall risk. However, per patient request, the plan of care was modified to incorporate balance training activities. The plan of care was aimed to correct these deficits, but ensured to include interventions that promoted lumbar extension and avoided lumbar flexion.

DIAGNOSIS AND PROGNOSIS

Based on a McKenzie mechanical evaluation, the patient was diagnosed with a derangement of the lumbar spine. Postural correction, lying prone on elbows (midrange lumbar extension), and repeated lumbar extension was able to reduce pain and improve walking. Based on this mechanical assessment and sustained positioning in lumbar extension, it was hypothesized the patient would benefit from a McKenzie-based lumbar exercise plan combined with positional, manual, and functional training. The prognosis had improved chances for positive rehabilitation outcomes when the plan of care is matched to the patient's direction preference.² However,

some of the impairments may be unrelated to the patient's derangement and stem from their MS.

INTERVENTIONS

The interventions selected for this episode of care were aimed to decrease pain, improve ROM, strength, walking tolerance, balance, posture, and functional independence to improve quality of life. The plan of care primarily focused on exercises utilizing the patient's directional preference, lumbar extension. The mechanically-based program was carefully progressed based upon decreased pain and patient report. Strengthening, endurance, and balance were incorporated into the plan as the patient tolerated increased activity. A summary for the plan of care can be found in Table 3.

Postural and Mechanical Education

Posture education began immediately after the initial evaluation was completed. Most patients develop chronic back pain from performing activities with poor posture and body mechanics.¹⁶ For example, "slouching" in a chair causes the natural lordosis of the lumbar spine to dissipate.

Assuming this posture while sitting for extended periods of time over multiple years eventually leads to some form of lower back problem.¹⁹ CS was prompted to avoid sitting in this position and any form of seat that does not provide proper maintenance of the lumbar lordosis. The patient was also shown how to protect her back by using a lumbar roll while sitting or driving. Back issues can also be triggered from poor sleeping positions. CS was informed sleeping in prone was the best position to sleep in. This position preserves the lordotic curve by facilitating slight lumbar extension. Sleeping in supine or on a side with knees tucked to the chest all night increases the chance of injury to the lower back.

Proper body mechanics were also included by demonstrating safe ways to perform activities that would otherwise be harmful to the lower back. It is important to always maintain the lumbar lordotic curve when reaching, bending, lifting, or performing any other activity that could put increased strain on the lower back. CS was instructed to bend at the knees, keep the back straight, keep the chest high, tighten the abs, and avoid looking down with any lifting activity. Accentuating maintenance of the curve in the lower back was also reinforced with all other activities as well.

Body mechanics were closely monitored and reinforced with each session. Corrections and advice were given as needed. Any form of unsafe flexing at the lumbar spine would counteract her directional preference and interventions resulting in extended rehab time.

Lumbar Extension Exercises

The interventions under this category were considered the most important part of the patient's plan of care. These exercises set the foundation for this subject's rehabilitation process with MDT. All other interventions were derived based on the patient's response to these exercises. A McKenzie-based lumbar extension protocol has a standard routine of progression for this clinic. First, CS began sessions by lying prone on the table. After one or two minutes, she was instructed to position herself into prone on elbows (POE) for two minutes. Finally, CS was instructed to perform 3 sets x 10 repetitions of prone press-ups, also known as repeated extension in lying (REIL). This required the patient to position their hands at chest height and push-up from the table until their arms were fully extended. She was informed to relax the entire lower back and let the mid-section of her body "sag." The patient held the press-up at the top for 2-3 seconds and returned to fully prone before the next repetition was completed. These were completed at the beginning of every session. CS was given two 2" thick pads to place under her hands starting the 4th week of treatment. This was to allow her to fully extend to end range. CS was always encouraged to push further into end range as tolerated. The purpose of these exercises is to offload the disc and tissues of pressure from poor posture and mechanics occurring throughout the day.

CS was also shown how to properly perform repeated extension in standing (REIS) when she was unable to find the time to get into a prone position. REIS was performed by positioning the posterior hip surface of the standing patient against a table to act as a leverage point for the hips. She was instructed to place both hands back on the table while continuing to face forward. The patient leaned back to achieve full range lumbar extension. A total of 3 sets by 10 repetitions were completed at the end of each session. This exercise was used to yield the same effect on the lower back as REIL.

CS was placed on a Repeated Endrange Passive Exercise (REPEX) table when all other exercises were completed for the session. The REPEX table enhances the effectiveness of end range movement. A REPEX table is able to passively position a patient into extension, flexion, or both. Movements can be precisely controlled by setting degrees, speed of movement, and amount of cycles. The REPEX table was only used for passive lumbar extension in this case report. There are 8 different levels of lumbar extension the table can achieve (Table 4). The back angle is increased along with each level. CS began at level 1 during the first week of treatment and progressed to level 7 by the end of care. The intervention was mainly intensified with increases in levels rather than the amount of cycles performed. A moist hot pack was applied to the patient's back during their time on the REPEX table. Heat was used to relax musculature of the lower back. The weekly progressions can be found in Table 4. The REPEX table was an excellent resource to increase the

number of cycles achieved for lumbar extension without the energy expenditure of performing repeated press-ups.

Spinal Mobilizations

Posterior-anterior (PA) mobilizations of each lumbar segment was performed during each session for 10 minutes. CS was positioned prone with arms relaxed at each side. PA mobilizations were performed by crossing the hands over, positioning one hand in a horizontal manner over a transverse process, and positioning the other hand vertically over the other transverse process. First week of treatment consisted of grade I mobilizations with 2-minute oscillations given at each segment. Oscillations occurred in sync with exhalation of the patient. Grade II mobilizations were used for weeks 2-3, Grade III for weeks 4-6, and Grade IV during weeks 7-8. The amount of time on each segment remained the same. Mobilizations have been found to reduce lumbar pain and improve lumbar extension.²⁰

Strengthening Exercises

Strengthening exercises began in the 2nd week of treatment to target deficits noted in the hip flexors, quadriceps, hamstrings, and gastrocnemius muscles. All strengthening interventions were conducted by a 3 set x 10

repetition protocol. Resistance or intensity was increased as the patient demonstrated improvement in performance. Box step-ups were incorporated as a strengthening component, but to also improve function with steps or curbs. CS began with 4" box in weeks 2-3, moved to a 6" box for weeks 4-6, and finished using an 8" box for weeks 7-8. Both legs completed the 3x10 protocol to ensure equality for each lower extremity. Standing calf raises were added during the 2nd week of therapy. Initially, CS experienced increased calf pain when performing the exercise. However, by the end of week 4, she was able to complete 30 repetitions of calf raises with no increase in pain or resting breaks. Thus, the exercise was discontinued because it was no longer challenging for the patient. Short-arc quad (SAQ) sets were introduced in week 3 of treatment. Initially, no weight was used for the first two days. 1# ankle weights were added on the third day, 2# ankle weights were used for the first half of the 4th week, and 3# ankle weights were used for the second half. The exercise was discontinued by the 5th week since 5/5 quad strength had been achieved. Bench squats were introduced at the end of week 4. CS began squatting onto a table that was 23" in height. She was instructed to lightly touch the table with her back side, ensuring to keep the weight through her legs, and stand back up. The table's height was decreased each week from 23" to 20" respectively. Beginning week 7, CS was given 2# dumbbell weights to hold and 3# dumbbell weights for week 8 to increase resistance.

Balance Exercises

Balance training began in the 5th week of treatment. Static balance was first addressed and eventually progressed to dynamic balance training. All activities required CS to be unsupported. The patient was positioned in front of a bar she could grab onto when she lost her balance. Different modifications to the balance activities were added to increase the intensity for the activity. These included preventing CS from looking down at her feet, alternating looking left and right during the activity, closing her eyes, and narrowing the base of support. Tandem stance for 3 sets x 1-minute intervals was the first balance exercise to be introduced. This exercise was selected to target impairments concerning her decreased balance when the base of support was narrowed. By the end of week 6, CS was able to hold this stance for 3 consecutive sets, without losing her balance, thus the exercise was discontinued at that time. The rocker board was also utilized at the start of the 5th week. The board was positioned in a way to challenge her anterior-posterior balance. Immediately following the AP exercise, the board was turned sideways to challenge side to side balance. This intervention lasted 8 minutes per session (4 minutes for each direction). Dynamic balance training began in week 6. All dynamic balance activities focused on ambulating over uneven terrain. Uneven terrain was simulated by placing six 2" pads on the ground. CS was instructed to walk over each pad (stepping

from pad to pad) without looking down. The exercise was intensified in week 6 by adding a 2" curb, a pad that simulated an incline, and a pad that wobbled when stepped on. Finally, in week 7, the pads were positioned in a way that forced CS to ambulate with a narrower base of support. Standing on a half foam roll was added to the plan of care in week 7. The patient attempted to stand on the half roll for 3 sets x 1-minute intervals.

Home Exercise Program (HEP)

A home exercise program (HEP) was prescribed to the patient after the initial examination. CS was instructed to always use a lumbar roll for proper back support while sitting. Also, the patient was told to avoid sitting on couches for extended periods of time. She was instructed to complete 3 sets x 10 repetitions of prone press-ups every 2-3 hours (4-6 times a day). REIS was to be performed instead of prone press-ups if CS was unable to get in the prone position at that point in time. The HEP heavily stressed the patient to use proper body mechanics (as taught in the clinic) and avoid any excessive or prolonged bending.

Table 3.

Summary of the plan of care over the 7 week treatment period.

Week #	MDT Exercises	REPEX Table	Strengthening	Balance Training	Spinal Mobilizations
1	1,2,5,6	9 (lvl 1/30 reps),7	X	X	Grade I
2	1,2,5,6	9 (lvl 1/70 reps),7	3,10	X	Grade II
3	1,2,5,6	9 (lvl 2-3/80 reps),7	3,10,14	X	Grade II

4	1,2,5,6	9 (lvl 3-4/70 reps),7	3,10,14	X	Grade III
5	1,2,5,6	9 (lvl 4-5/100 reps),7	3,8	11	Grade III
6	1,2,5,6	9 (lvl 7/100 reps), 7	3,8	11,12	Grade IV
7	1,2,5,6	9 (lvl 7/100 reps), 7	3,8	11,12	Grade IV

Table 3 Key	
1=posture education (included every week)	8=bench squats
2=repeated extension in lying (REIL)	9=REPEX table
3=Box step-ups	10=Heel raises (bilateral)
4=lumbar spine PA mobilizations	11=static balance training
5=body mechanic education	12=dynamic balance training
6=repeated extension in standing (REIS)	13=SAQs
7=moist heat for lower back	X= intervention did not occur

Table 4.

REPEX table levels and their equivalent lumbar ranges.

REPEX Table Parameters			
Level	Angle (degrees)	Week	Cycles
1	Extension: -2°-13°	1	30
2	Extension: -1°-15 °	2,3	70
3	Extension: 0°-18 °	4	100
4	Extension: 0°-20 °	4,5	100
5	Extension: 1°-23 °	5	100

6	Extension:1°-25 °	6	100
7	Extension: 1°-27 °	7	100
8	Extension: 1°-29 °	X	X

OUTCOMES

Active Lumbar extension and flexion increased from 0-10° to 0-30° and 35 cm to 5 cm respectively. Both improvements were accomplished by the 4th week of therapy. All MMT scores improved over the episode of care. Hip flexors improved from 3+/5 to 4+/5, quadriceps and hamstrings 4/5 to 5/5, and gastrocnemius 3-/5 to 4+/5. CS had no increases in pain with all AROM and MMT testing at the final examination. Lower back pain scores also improved (7/10 to 2/10). However, bilateral calf pain showed no improvements (6/10 to 5/10). Gait tolerance increased from an ambulation time of 5 minutes to 20 minutes. CS stated she was able to cook full meals and shop at the grocery store without needing to take a sitting break due to pain. CS did not score as a fall risk on the BBS, but improved their score from a 50 to 55. She reported feeling more stable when walking over uneven surfaces such as grass. ODI scores revealed a significant improvement from being severely disabled (48%) to mild disability (18%).¹⁶ All treatment goals were accomplished except for the goal regarding calf pain. CS demonstrated

improved gait endurance, stair ambulation, and less pain when performing ADLs and IADLs.

DISCUSSION AND CONCLUSION

The purpose of this case report was to investigate if a patient previously diagnosed with MS and currently diagnosed with LBP would be capable of fully abolishing their pain and improve functional performance with daily activities regardless of the limitations caused by MS. The initial evaluation revealed the back pain occurring at the lumbar spine was mechanical in nature. However, it was still unknown if the lower leg pain was related to CS's current back issues or her MS. The patient was able to decrease their back pain to a 2/10 by the 4th week of therapy. The reduction in pain was considered clinically significant.¹⁴ This score was held constant for the remaining episode of care. MDT has been shown to rapidly reduce or abolish symptoms resulting from a derangement of the lumbar spine.² Most individuals are able to treat and maintain their pain once they are provided with the proper knowledge and tools. Lower leg pain made no significant improvements. Leg pain is often associated with lumbar spine conditions resulting with nerve impingement(s).⁸ Typically leg pain is alleviated along with back pain when a nerve root is involved. However, the two appeared to

be unrelated in this scenario. Nonspecific pain is quite common for individuals diagnosed with MS.⁵ One study reported out of 10,176 subjects, 49% of participants reported some form of mild to severe pain.⁵ REIL, spinal mobilizations, and REPEX table interventions all resulted in decreased back pain at the end of each session. These forms of interventions are designed to off-load tissue and disc pressure from the lower back. Thus, it was somewhat expected to see some form of pain relief.

Functional AROM was achieved by the 4th week of therapy. Lumbar flexion appeared to be strictly limited by increased pain. Lumbar flexion and pain levels were inversely related. Lumbar flexion increased as pain continued to decrease. Lumbar extension was stiff, but not painful. Most individuals fail to utilize proper posture and body mechanics throughout the day.¹⁹ CS had admitted to sitting in a flexed position and unsafely bending with home activities for years. This eventually leads to a loss of the lumbar spine's lordotic curve.²¹ Ultimately, lumbar extension became limited and other back problems follow suit.¹⁹ CS experienced discomfort with prone press-ups initially due to her extension limitations. However, significant gains of lumbar extension were made over the treatment period.

CS's lower extremity strength improved in all planes, especially hip flexors, quadriceps, hamstring, and gastrocnemius muscles. Also, the patient demonstrated increased endurance with mobility. It could be hypothesized both categories of improvement (strength and endurance) were due to

decreased back pain with activity. Sitting breaks were still required after 20 minutes due to calf pain, but this was enough time to complete activities such as cleaning, cooking, and grocery shopping. White et al. found individuals with MS are capable of making positive outcomes with resistance training that lead to improved ambulation and endurance. The study used knee extension, knee flexion, and plantar flexion exercises for strengthening, which were also interventions used in this case report.²² Another study using a home-based resistance exercise program led to positive gains in lower extremity strength, but failed to improve balance and mobility.²³ The patient in this case report matches the results of the study's outcomes with exception to unimproved mobility. Elimination of pain along with increased endurance could be attributed to the patient's improved mobility. The first 4 weeks only consisted of mechanically-based and strengthening exercises. Balance was not objectively assessed in these first 4 weeks, therefore we cannot propose what effects these interventions had on balance.

CS presented to therapy with an increased base of support, but was never objectively found to be an increased fall risk. Soyuer et al. found balance is commonly impaired in all forms of MS patients.²⁴ Specifically, individuals with relapsing remitting multiple sclerosis performed worse with tandem stance and single leg stance in comparison to the control group.²⁴ CS also had difficulties with these two balance exercises during the BBS.

Martin et al. showed individuals recently diagnosed with MS may have motor function deterioration in the beginning stages of the disease. Data from the study indicated increased double limb support, reduced gait speed, and decreased stride length. Though they were not objectively measured, CS presented the same impairments based on clinical observation. She also reported changes in her ambulation recently after she was diagnosed with MS. This statement also supports the findings of early motor deterioration with MS. The balance exercises used in the plan of care provides proprioceptive feedback and challenged the patient's ability to self-correct. CS reported "burning" of the calf muscles after completing balance exercises. The exercises may have gastrocnemius strengthening as a secondary beneficiary. Improved proprioception and calf strength to self-correct possibly contributed to CS's increased sense of security and confidence while ambulating across uneven surfaces.

There is no research supporting the use of a tape measure to record the distance from the tip of the 3rd digit to the floor for lumbar flexion. Slight knee flexion may occur as a substitution movement while measuring lumbar flexion with this method. The BBS may not have been the appropriate outcome measure to test balance for this patient. CS presented impaired balance performance when her base of support was narrowed, but was still able to receive full scores for these parts of the BBS. An outcome measure with dynamic balance components such as the Functional Gait Assessment

or High-Level Mobility Assessment may have been more appropriate. Gait analysis was all based on clinical observation. Thus, predictions of the patient's outcomes relating to gait lack statistical support. The patient's swimming routine could have contributed to improvements. Research has shown an aquatic-exercise program can help improve quality of life for individuals with MS.²⁶ Finally, exacerbations did not occur during this period of treatment. Relapses may have altered the patient's outcomes.

There are currently no studies investigating the effects of MDT for patient's diagnosed with MS. The patient from this case report was able to improve her overall quality of life by using McKenzie-based interventions combined with LE strengthening, balance exercises, and education. However, CS was unable to decrease calf pain or improve her gait pattern. Further research should include follow-ups post 6 and 12 months of therapy to see if these improvements can be maintained. Also, studies should include research supported interventions for individuals diagnosed with MS combined with a mechanically-based approach to yield optimal pain relief and functional improvement.

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Table 2.

Summary of patient results at initial examination, week 4, and week 7.

OUTCOME MEASURE	INITIAL EXAMINATION	WEEK 4	WEEK 7
AROM	Lumbar Extension: 0°-10° Lumbar Flexion: 35 cm*	Lumbar Extension: 0°-30° Lumbar Flexion: 5 cm*	Lumbar Extension: 0°-30° Lumbar Flexion: 5 cm*
MMT (BILATERAL)	Hip Flexion: 3+/5	Hip Flexion: 4+/5	Hip Flexion: 4+/5
	Knee Flexion: 4/5	Knee Flexion: 5/5	Knee Flexion: 5/5
	Knee Extension: 4/5	Knee Extension: 5/5	Knee Extension: 5/5
	Dorsiflexion: 5/5	Dorsiflexion: 5/5	Dorsiflexion: 5/5
	Plantar flexion: 3-/5	Plantar flexion: 3+/5	Plantar flexion: 4+/5
NUMERIC PAIN RATING SCALE (1-10) RESTING	Low Back: 7/10 Lateral Calves: 6/10	Low Back: 2/10 Lateral Calves: 5/10	Low Back: 2/10 Lateral Calves: 5/10
GAIT	Walking Tolerance: 5 minutes(+)	Walking Tolerance: 20 minutes(+)	Walking Tolerance: 20 minutes(+)
BERG BALANCE TEST	X	50/56	55/56
REVISED OSWESTRY	Score: 48% (severe disability)	Score: 18% (mild disability)	Score: 18% (mild disability)

